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ABSTRACT

Two separate studies were conducted: 1) one examining the effect on sixth grade subjects (N=113) of relevant questions occurring shortly after reading textual material on posttraining tests to a control condition not receiving the questions, and 2) one replicating it and also examining learning in small group (individual-like situations) as well as intact classrooms, and comparing the performance of sixth graders (N=96) and college students (N=74) on the same content. Data for the first study consisted of the number of correct responses by each student to the three daily 12-question posttests and the 18-question post-posttest; for the second study the number of correct responses by Ss to a 16-item posttest and a 20-item post-posttest. Results were submitted to means tests and analysis of variance to determine the effects on performance of class, day, conditions, type of administration, and their possible interactions. The study failed to support previous studies: There was no general facilitative effect of interspersed questions (after relevant text material) on incidental learning. No experimental differences were found when sixth graders were treated in intact classroom situations vs. small groups, and no differences were found that could be attributed to days with respect to short term and delayed retention. If "mathemagenic behaviors" are generated in children, they do not seem to take the same form as those reported in young adults. (JS)

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THE EFFECT OF INTERSPERSED QUESTIONS ON LEARNING FROM WRITTEN MATERIALS IN ELEMENTARY SCHOOL CHILDREN AND COLLEGE STUDENTS

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OBJECTIVES:

Rothkopf (1969) has defined mathemagenic activities in the following way..."the study of mathemagenic activities is the study of actions on the part of the student that are relevant to the achievement of specified instructional objectives (p. 2)." Most of Rothkopf's recent work, and that of several others, has dealt with the effect of interspersed questions (or test like events) in reading material on immediate recall (retention). The effect of systematically varied interspersed questions has provided some consistant findings with important implications for the organization of school reading materials. Several studies (Bruning, 1968; Rothkopf, 1966; Rothkopf and Bibiscoe, 1967; Frase, 1967) support the contention ..."that adjunct questions (interspersed questions) administered shortly after inspecting (reading) the text segment to which they are relevant, affect mathemagenic activities. The change has shown up on post-training tests where performance is superior to performance of no question control groups and groups who saw questions (the same questions) prior to inspecting the text segment to which the questions were relevant (Rothkopf, 1969, pp. 8-9).

All the studies done to date have examined the mathemagenic activities of college or senior high school students. The object of this investigation was to determine whether the same mathemagenic activities that have been demonstrated

to operate in the reading behavior of college and high school students also operates in the reading behavior of younger children. It was expected that younger children, having less well developed reading skills and different orientation towards the reading/learning process would not exhibit the same mathemagenic behaviors as blder children.

METHOD:

The reported investigation includes two separate studies. The first study (Study 1, Spring 1970) examined the effect on 6th grade elementary school subjects (N=113) of relevant questions occuring shortly after reading textual material on post-training tests to a control condition not receiving the questions. The second study (Study 2, Fall 1970) replicated Study 1 and also examined learning in small groups (individual-like situations) as well as intact classrooms, and compared the performance of 6th graders (N=90) and college students (N=74) on the same content.

Study 1.

Subjects:

The subjects in the study were 113 students (69 male, 44 female) comprising the four 6th grade social studies classes taught by one teacher in a middle class-suburban elementary school in western Massachusetts. Class size

ranged from 28 to 30 students. Those students having severe reading problems were eliminated from the study.

Procedure:

Within each of the four classes all subjects were randomly assigned to the group with interspersed questions (Q) and the group without interspersed questions (NQ). Since 6th graders are known to have a shorter attention span and slower reading rates than adults, the study was run over three successive days in the school, followed by a follow up test a week after the end of the three day period. On each of the three days of the experiment, subjects in the Q and NQ conditions, by class, were each given a packet of materials containing a set of instructions, six pages of reading material, and a post-test based on the reading. The initial instructions for both Q and NQ conditions were the same. These were read aloud by an experimenter with each class before each session. Subjects then worked through the experimental materials at their own rates at their desks and completed a post-test after each day's reading. The classroom teacher and one of the experimenters monitored the sessions and answered questions that arose. Each session was carried out in one 50 minute class period. A week after the 3rd day of the study, a post-post-test was administered to all subjects in each class.

Materials:

For each of the three successive days of the experiment

two sets of reading materials were prepared (six sets in all). One set for each day was composed of six pages of printed text materials. At the top of pages following each page of text was a series of three fill-in-the blank questions that were related to the previous page of text. On a page at the end of the six pages of reading material was a 12 question, fill-in-the-blank Post-Test composed of two questions from each of the six pages of text. The Post Test questions were designed to be independent in content from the experimental (interspersed) questions. (Independence was determined by separate ratings by the two experimenters). Together with a cover page of instructions, these materials composed a packet for the Q condition. Three sets of such materials were developed, one for each of the 3 days.

The packets of material for the NQ condition were identical to those for the Q condition except that the experimental questions were eliminated. Thus, an NQ packet contained instructions, six pages of test with interspersed questions, and a post test.

In the instructions specific to the Q condition, subjects were instructed to read through each page of text and answer the questions that occured at the top of each page. To the right of each question was a tab with the correct answer under the tab. S's were instructed to write their response on the tab and then check their answer by lifting the tab.

The Post-Post-Test (administered 1 week after the 3rd day of the study) was composed of 18 multiple choice questions. One question was derived from each of the six pages of text for each of the three days. All questions were judged independent of the Post-Test questions. Nine of the questions were judged independent of the experimental (interspersed) questions, and nine were judged dependent.

The text materials for each of the three days were based on different aspects of Latin American history and politics, an area of work the four classes were entering at the same time. Prior knowledge of the content was judged minimal and differences were assumed to be randomly distributed across conditions.

DATA SOURCES:

The data in study 1 was the number of correct responses by each student to the three daily Post-Test (12 questions each), and the Post-Post-Test (18 questions). Table 1 summarizes the number of students in each of the four classes completing each test.

Table 1

Number of Subjects by Class and Condition Present on Each Day and on All Days of Study 1

Class	Condition	Daily Post Test 1	2	3	Post-Post-Test	Present on all days	Assigned to Condition
1	Q	9	10	9	13	7	13
	NQ	14	12	15	15	11	15
2	Q	15	15	16	15	13	16
	NQ	13	12	12	13	12	13
3	Q	11	14	14	15	11	15
	NQ	12	14	13	14	10	14
4	Q	12	12	14	12	11	14
	NQ	14	15	14	15	13	16
total	Q	47	51	53	55	42	57
	NQ	53	53	54	57	46	59
total		100	104	107	112	88	116

RESULTS:

The results of the study were submitted to means tests and analysis of variance to determine whether class, day, or condition had an effect on performance on the three post-tests and the post-post-test. The means for subjects present on all 4 days of study are summarized in Table 2.

Table 2

Mean Number of Correct Responses on Post-Tests and Post-Post-Test for Q and NQ Conditions for 88 s's present on all 4 days of study.

Condition	Day 1 PT	Day 2 PT	Day 3 PT	total PT	PPT
Q n=42	4.85	4.95	5.09	4.96	11.07
NQ n=46	5.58	5.54	5.00	5.37	8.93

An analysis of variance revealed no significant differences at .05 level between Q and NQ conditions and between days 1, 2, and 3 post-tests. See table 3.

Table 3

Analysis of Variance Comparison of Q and NQ Conditions on 3 Daily Post Tests

Source	SS	df	MS	F	
Days	2.3889	2	1.194	.2516	ns
Condition	8.0357	1	8.0357	1.6929	ns
Days x Condition	9.5000	2	4.750	2.455.	ns
total	187.57	246			

An analysis of variance was done on the post-post-test scores to determine effects of variables under study on retention after one week. These results are summarized in Table 4.

Table 4

Analysis of Variance Comparison of Q and NQ Conditions and Classes on the Post-Post Test

Source	SS	df	MS	F	
Class	44.25	3	14.75	1.86	ns
Condition	92.00	1	92.00	11.61	sign. >01
Class x Condition	13.13	3	4.38	0.06	ns
total	783.19	80			

The effect of experimental questions was found to be significant. Subjects receiving experimental questions in the study performed significantly better on the Post-Post-Test than did subjects without experimental questions.

Further analysis of the Post-Post-Test data was made to determine whether the effect of the experimental questions was a general effect, or operated to improve performance only on PPT questions that had transfer value from experimental questions. The PPT was originally designed to include 9 transfer items and 9 non-transfer items (related to experimental questions and not related). Post hoc examination suggested that 2 items originally designated non-transfer were in fact transfer items. Thus, this analysis was done on 11 transfer and 7 non-transfer items. T tests were used to compare Q and NQ performance on the PPT on transfer and non-transfer items. A significant difference in favor of the Q condition was found on transfer items ($t=3.689$, $df=88$, sign. $> .01$). No difference was found on non-transfer item performance ($t=0.387$, $df=88$).

Answers to PPT questions were further categorized as familiar vocabulary (FV) and new vocabulary (NV). The performance of Q and NQ conditions on FV and NV, and FV transfer vs. no transfer and NV transfer vs. no transfer items was made. Both Q and NQ conditions had significantly higher performance on FV items than NV items on PPT ($t=2.001$, sign $>.05$, $t=2.969$, sign $>.05$ respectively.). Table 5 shows other comparisons of means of Q and NQ conditions.

Table 5

t Comparisons of Q vs. NQ Conditions

New vocabulary	t 1.711	NS
NV non transfer	t 0.183	NS
NV transfer	t 1.590	NS
Familiar vocabulary	t 1.273	NS
FV non transfer	t 0.905	NS
FV transfer	t 2.485	sign $>.05$

The significant difference between Q and NQ conditions on PPT items is clearly accounted for by superior Q performance only on Familiar vocabulary transfer items.

A last result of the study regards time spent working by students in the experimental periods. With respect to time, subjects in Q condition spent longer working through their experimental readings and less time answering the questions on the post-tests than did subjects under NQ condition. Time results are summarized in Table 6. Time differences were not examined for statistical significance.

Table 6

Mean Time Spent Reading Experimental Materials and Answering Post-Test in Minutes

	Reading	Post-Test
Q	15.17	8.86
NQ	10.26	9.62

Summary Study 1:

The results of Study 1 found no general facilatative effect of interspersed questions occuring after textual material. The facilatative effect that was found held true only on the PPT items having transfer value from the interspersed question. No general incidental effect was observed. In addition, interspersed questions were observed to increase reading time of textual material but decrease time required to answer PT items. No differences were observed over the 3 consecutive days of the study.

Study 2

Subjects:

The subjects in the second study were 96 sixth grade students (47 female, 49 male) in four science classes taught by one science teacher, and 74 college students enrolled in two sections of educational psychology at Mount Holyoke College. The sixth graders were from the same school as the subjects in study 1.

Procedure:

The procedure for sixth grade subjects was essentially the same as in study 1, with the following exceptions: Ss read one six page selection on one day under either Q or NQ conditions. In addition, one half of the Ss in both Q and NQ conditions read their materials and took both the post test and post-post-test in small groups of 4 to 6 in a room other than the classroom. This was structured to be an "individual" as apposed to group (intact classroom) situation. Each of the 4 classrooms of Ss were randomly assigned to Q and NQ conditions. Ss within one of the Q and one of the NQ classes were assigned small groups.

Within the two classes of college students, one was assigned as the Q condition and the other as the NQ condition. In addition, one half of each group was given a six question completion type pre test (see materials) that was attached to the beginning of their reading materials.

Materials:

The sixth grade materials were constructed essentially the same as in study 1 with the following exceptions: the content of the reading was scientific-descriptive material about whales written at a sixth grade reading level; two interspersed questions were presented after each page of text material (instead of 3) under Q condition.

The materials for college students were identical to those of 6th graders except that three additional pages of text material (with interspersed questions in Q condition) were inserted after page 3 of the sixth grade materials. This made a total of 9 pages of text material for college Ss. The questions for the college pre-test were completion type and taken from the 3 added pages of text.

Data Sources:

The data in study 2 was the number of correct responses by Ss to the PT (16 completion items), the PPT (20 multiple choice items), and the responses of one half of the college Ss on the pre-test (6 completion items). Table 7 presents the number of Ss under each condition.

Table 7

Number of Subjects Under Each Condition

	Condition	6th grade	College pre-test	College no pre	College PPT only
In Classroom	Q	25	14	16	14*
	NQ	21	14	16	
In Small Groups	Q	24			
	NQ	26			

*14 college Ss, absent on day 1 took the PPT only

Results: 6th graders

The means of 6th graders under each condition are summarized in Table 8.

Table 8

Mean Number of Correct Responses on PT and PPT Under Q and NQ Conditions for Sixth Graders

	Type of Group	Post Test (16 items)	Post-Post Test (20 items)
Q	class	6.08	10.96
	individual	6.75	12.00
	total	6.40	11.46
NQ	class	7.19	9.09
	individual	6.34	7.80
	total	6.72	8.38

A 3 way analysis of variance was run to determine effect of conditions (Q vs. NQ), type of administration, and their possible interactions with the tests. The results are summarized in Table 9.

Table 9

Source	SS	df	MS	F	
Condition	132.15	1	132.15	3.997	*
Administration	25.15	1	25.15	0.761	
Cond. x Admin.	0.05	1	0.05	0.002	
Conditions x Test	217.15	1	217.15	6.568	*
Admin. x Test	18.01	1	18.01	0.545	
Cond x Admin x Test	679.62	20	38.98	0.908	
total	6301.52	160			

*significant > .05

No differences were found between types of administration (intact classroom vs. "individual" groups). Significant differences were found between Q and NQ conditions and in the interaction between conditions and test. T tests revealed no differences between Q and NQ conditions on the PT, though differences were found on the PPT results ($t = 4.991$, $df = 94$, sign. $> .01$).

The PPT results were further analysed to determine whether the superior Q condition performance was the same on transfer and non-transfer questions. Differences were in favor of Q condition (vs. NQ) on transfer questions ($t = 8.1647$, $df = 94$, sign. $> .01$). No differences were found between Q and NQ conditions on non-transfer PPT questions ($t = 0.6956$, $df = 94$, ns). In addition, both Q and NQ conditions did significantly better on PPT questions classed as familiar vs. new vocabulary ($t = 4.119$, $df = 44$, sign. $> .01$; $t = 2.129$, $df = 48$, sign. $> .01$). Further analysis revealed the differences in favor of Q condition was <u>only</u> on new vocabulary and familiar vocabulary <u>transfer</u> questions.

Table 10

T Comparisons of Q vs. NQ conditions on PPT Data

Type of items	t value	df	significance
New Vocabulary	3.401	94	>.01
NV - nontransfer	0.364	94	ns
NV - transfer	6.236	94	>.01
Familiar Voc.	5.249	94	>.01
FV - nontransfer	0.584	94	ns
FV - transfer	8.325	94	>.01

Results: College Students

Table 11

Mean Number of Correct Responses on Pretest, Post Test, and Post-Post Test of College Students for Q, NQ (and PPT only) Conditions

Condition	6 Question Pretest	16 Question Post Test	20 Question Post-Post Test
Q	1.21	11.41	15.32
NQ	1.14	11.23	12.76
PPT only	-	-	10.21*

*14 Ss were present for the PPT only

Table 11 summarizes the performance of college Ss under Q and NQ conditions. Differences were found in favor of the Q (vs. NQ) condition on the PPT ($t = 5.663$, $df = 59$, sign. $> .01$) but not on the PT ($t = 0.319$, $df = 59$, ns). Further analysis showed that the Q condition did better than the NQ condition on the PPT transfer items ($t = 6.342$, $df = 59$, sign. $> .01$) but not on the PPT non-transfer items ($t = 1.527$, $df = 59$, ns). In addition, both Q and NQ performance on PPT items was significantly different than performance on the PPT of those Ss having the PPT only. No differences between pretest and non pretest Ss were found under Q and NQ conditions.

Summary of Results:

1. In study 1 and study 2 no differences on Post Test performance between groups receiving interspersed questions after relevant text material (Q) and groups not receiving interspersed questions (NQ) were found for either 6th grade

or college subject samples.

2. In study 1, significant differences in favor of Q condition were found on the Post-Post Test performance of 6th graders. The same results were found in study 2 for 6th graders and college students. Sixth graders in study 1 under the Q condition performed better only on PPT familiar vocabulary transfer items. In study 2, 6th graders performed better on on both familiar and new vocabulary transfer items.under the Q condition. College Ss under Q condition performed significantly better than NQ condition Ss only on transfer items on the PPT. No differences were found in any part of the study where Ss under the Q condition performed better than the NQ condition Ss on PPT questions that were not transfer questions.

3. There were no differences between the performance of 6th grade Ss on the PT and PPT within either Q or NQ conditions with respect to the type of experimental setting (intact classroom vs. "individual" settings).

4. In study 1, there was no effect of the number of days the study was carried out over on daily PT performance nor on PPT performance.

Conclusions:

Implications from previous studies of this type have suggested that incidental learning from written materials can be facilitated if interspersed questions follow shortly after relevant textual materials (Rothkopf, 1969). Prior studies have dealt exclusively with college and high school subjects and have not attempted to measure retention of experi-

mental gains beyond the post training type test. The present investigation assessed the effects of interspersed questions (after relevant text) on the incidental learning of 6th grade subjects over days, in intact classrooms vs. individual reading situations, and on a delayed test (one week). In addition, the effects on 6th graders and college students on the same text passages were examined.

With respect to both 6th graders and college students the consistent result was that there was no general facilitative effect of interspersed questions (after relevant text material) on incidental learning. Subjects receiving interspersed questions did perform better on the delayed test (PPT), than subjects not receiving questions, but the differences were entirely accounted for by performance on items having transfer value from interspersed questions. Thus the present study fails to support previous studies with respect to interspersed questions (Rothkopf, 1969) and college students. In addition, no "mathemagenic" effects were observed in 6th grade subjects.

With respect to experimental techniques, the present investigation (study 2) found no experimental differences when 6th grade students were treated in intact classroom situations vs. small groups. The small groups were designed to approximate a situation in which individual subjects worked alone. No differences were found between the two types of experimental situations, suggesting that group administrations (intact classrooms) of <u>this class</u> of tasks probably yield results that are the same as results in individually administered task situations. Also, the current investigation (study 1)

with 6th graders was carried out over three consecutive days with the expectation that any experimental effects might be different on day 1 than on day 3. No differences were found that could be attributed to days with respect to short term and delayed retention (PT and PPT results). While it would be unwarranted to suggest that number of days can not have an effect in this type of a study, none was observed in the present study involving 3 consecutive days.

If "mathemagenic behaviors" are generated in children, they do not seem to take the same form as those reported in young adults. In addition, the current study does not support the findings of previous studies regarding the facilitative effect of interspersed questions. This suggests that any generalizations of the implications of studies of adult "mathemegenic behaviors" to children are probably invalid. Support for this conclusion was found in a study similar to the present one (study 1) using third grade subjects (Wadsworth, Bedle, and Gatland, 1970). No differences between Q and NQ conditions were found either in immediate or delayed testing. Clearly, a replication of adult studies of mathemagenic behaviors with samples of children is required to to determine whether and how mathemagenic activities interact with age and other variables.